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(54) Continuous extrusion of chocolate

(57) A process for the continuous extrusion of chocolate or a fat-containing confectionery material using a screw extruder 10 which comprises feeding the chocolate or fat-containing confectionery material into the screw extruder and generating a pressure to force the chocolate or fat-containing confectionery material in a substantially solid or semi-solid nonpourable form upstream of a flow constriction whereby the temperature of the screw 17, the temperature of the barrel wall, the screw speed, pressure, contraction ratio and extrusion rate are such that the chocolate or fat-containing confectionery material is extruded in a substantially solid or semi-solid nonpourable form to produce an axially homogeneous extruded product having a cross section that is of substantially the same profile as the die exit 16 of the extruder 10, which is capable of retaining its shape and which has a temporary flexibility or plasticity enabling it to be physically manipulated or plastically deformed before losing its flexibility or plasticity.

FIGURE 1

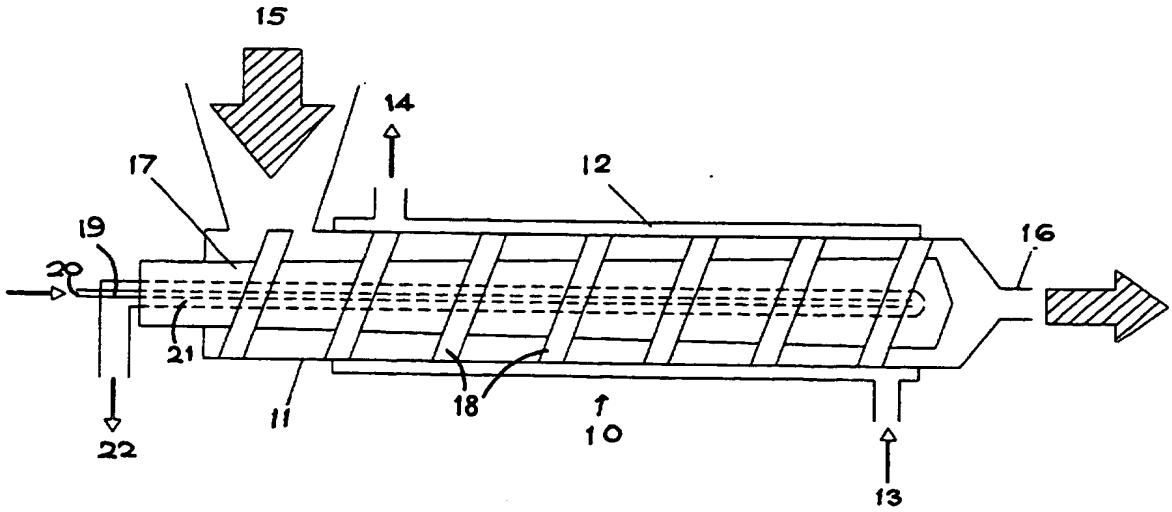

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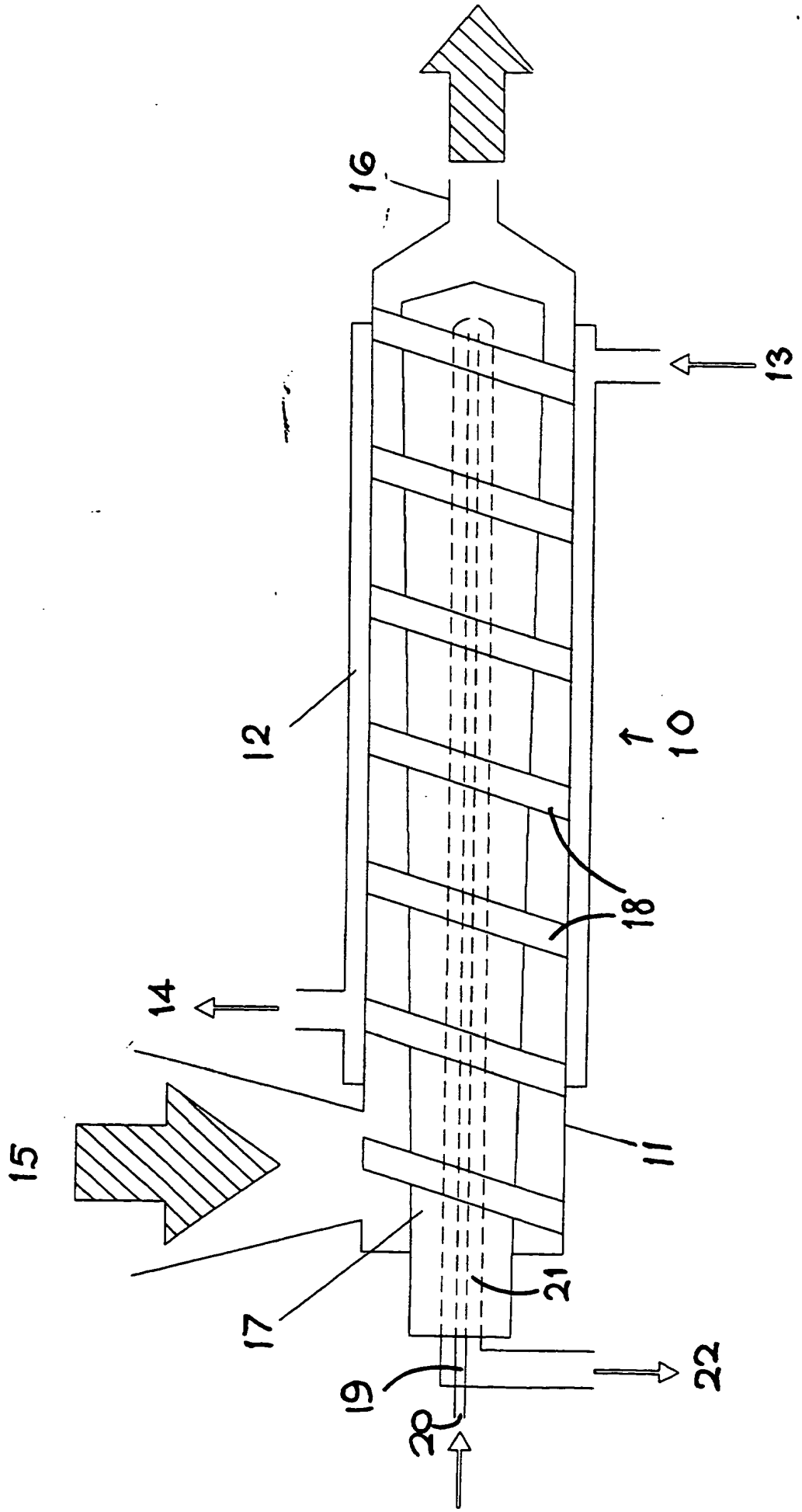
FIGURE 1



Continuous Extrusion of Chocolate

The present invention relates to the extrusion of chocolate and more particularly to a process for the continuous extrusion of solid or semi-solid chocolate using a screw extruder.

In our co-pending EP-A-93114251.7, the entirety of which is hereby incorporated by reference, we describe a process for plastically extruding a fat-containing confectionery material which comprises feeding the fat containing confectionery material into an extruder and applying pressure to the fat-containing confectionery material in a substantially solid or semi-solid nonpourable form upstream of a flow constriction whereby the temperature, pressure, contraction ratio and extrusion rate are such that the fat-containing confectionery material is extruded and remains in a substantially solid or semi-solid nonpourable form to produce an axially homogeneous extruded product having a cross section that is of substantially the same profile as the die exit of the extruder, which is capable of retaining its shape and which has a temporary flexibility or plasticity enabling it to be physically manipulated or plastically deformed before losing its flexibility or plasticity.

The extrusion process may be carried out batchwise or continuously and some examples of advantages of continuous extrusion are:

a) the flow rate is constant and uninterrupted, and

b) coextrusion is simpler because the chocolate or fat-containing confectionery material is extruded at a constant rate.

However, when carrying out continuous extrusion using a screw extruder, heat may be generated by the friction of the shear of the chocolate between the screw and the barrel wall. This heat tends to raise the temperature so that the chocolate melts and the liquefied fat of the melted chocolate acts as a lubricant causing the chocolate to slip against the barrel wall which prevents it flowing efficiently. It is important that the chocolate should stick sufficiently to the barrel wall to give some resistance enabling it to flow efficiently against the back pressure of the die and there should not, therefore, be any appreciable melting of the surface of the chocolate in contact with the barrel wall.

In contrast, in order for the screw to advance the chocolate downstream efficiently, there should be a certain slippage of the chocolate against the screw. However, it is important that the chocolate should not melt since this would cause the chocolate to stick to the screw leading to blockages in the barrel.

We have found that, by careful control of the temperature of the barrel wall and of the screw, we can ensure that the chocolate remains in a substantially solid or semi-solid state with a suitable degree of slippage against the screw enabling an efficient flow through the barrel.

According to the present invention, there is provided a process for the continuous extrusion of chocolate or a fat-containing confectionery material using a screw extruder which comprises feeding the chocolate or fat-containing confectionery material into the screw extruder and generating a pressure to force the chocolate or fat-containing confectionery material in a substantially solid or semi-solid nonpourable form upstream of a flow constriction whereby the temperature of the screw, the

temperature of the barrel wall, the screw speed, pressure, contraction ratio and extrusion rate are such that the chocolate or fat-containing confectionery material is extruded in a substantially solid or semi-solid nonpourable form to produce an axially homogeneous extruded product having a cross section that is of substantially the same profile as the die exit of the extruder, which is capable of retaining its shape and which has a temporary flexibility or plasticity enabling it to be physically manipulated or plastically deformed before losing its flexibility or plasticity.

The chocolate material may be dark, milk or white chocolate. Fat containing confectionery materials may include sugar, milk derived components, and fat and solids from vegetable or cocoa sources in differing proportions having a moisture content less than 10%, more usually less than 5% by weight. They may be chocolate substitutes containing direct cocoa butter replacements, stearines, coconut oil, palm oil, butter or any mixture thereof; nut pastes such as peanut butter and fat; praline; confectioner's coatings used for covering cakes usually comprising chocolate analogues with cocoa butter replaced by a cheaper non-tempering fat; or "Caramac" sold by Nestlé comprising non-cocoa butter fats, sugar and milk. Since the fat containing confectionery material contains less than 10% water, flour confectionery products such as cakes and pastries are excluded.

The temperature of the screw may be controlled, for instance, by a fluid such as water at the appropriate temperature flowing through the interior of the screw. For example, the fluid may enter at the upstream end and flow to the downstream end through one or more longitudinal channels and return through one or more longitudinal channels to the upstream end where it exits. The

temperature of the barrel wall may be controlled, for instance, by a fluid such as water or glycol or a mixture thereof at the appropriate temperature flowing through a jacket surrounding the barrel wall.

The temperatures of the screw and the barrel wall may be controlled according to the type of fats present in the material being extruded. For example, fats having higher melting points usually require a warmer barrel wall and screw than fats having lower melting points. The degree of flexibility of the extruded product may be affected by the temperature and the melting point of the fats present in the material being extruded.

With regard to the screw temperature, if the temperature is too low the chocolate will adhere to the screw and will not flow whereas if the temperature is too high the chocolate melts causing blockages. Depending on the type of fats present in the material being extruded, the temperature of the the screw may be from 10° to 35°C, and more usually from 15° to 30°C.

With regard to the barrel wall temperature, if the temperature of the barrel wall is too high, the chocolate melts and slips against the wall and does not flow efficiently. Depending on the type of fats present in the material being extruded, the temperature of the barrel wall may be from -50° to +20°C, more usually from -25° to +15°C. Often, the temperature of the barrel wall may conveniently be lower than the incoming chocolate or fat-containing confectionery material but, in some circumstances, the temperature of the barrel wall may be higher than the incoming chocolate or fat-containing confectionery material.

Conveniently, the temperature of the screw is greater than the temperature of the barrel wall, for instance, by from 5° to 50°C, preferably from 10° to 40°C and more preferably from 12° to 30°C.

In one advantageous embodiment the diameter of the screw root increases from the upstream to the downstream end while the pitch remains constant. In another advantageous embodiment the pitch of the screw decreases from the upstream to the downstream end while the diameter of the screw root remains constant.

The compression ratio of the screw may be from 1:1 to 5:1 and preferably from 1.5:1 to 3:1. Compression ratios above 5:1 may cause blockages of the material being extruded. The ratio of length to diameter of the screw may be, for instance, from 5:1 to 30:1 and preferably from 10:1 to 25:1.

The diameter of the screw may be, for example from 20 to 500mm. The screw speed may be, for example, from 1 to 500rpm. The actual screw diameter and screw speed may be selected by the person skilled in the art according to the requirements. The throughput depends on the screw speed and may be, for instance, from 1 to 5000kg/hr according to requirements.

If desired, two or more fat-based confectionery materials may be extruded in accordance with the process of the present invention. In addition, the chocolate or fat-containing confectionery material may be co-extruded with other food materials such as ice cream, sorbet, yoghurt, mousse, fondant, praline, marshmallow, nougat or jelly, etc., such being advantageous when the fat-containing confectionery material is extruded in a hollow or tubular form. Hence, in such embodiments, a multi-orifice die

and/or associated equipment, as are known to those skilled in the art, may be employed.

If desired, a twin screw extruder may be used and may be either one using counter-rotating screws or one using co-rotating screws.

The temperature of the chocolate or fat-containing confectionery material as it is extruded may conveniently be from 15° to 28°C, more usually from 18 to 25°C, e.g. from 20° to 23°C.

The present invention will now be further described by way of example only with reference to the accompanying drawing in which Figure 1 represents a schematic diagram of a continuous extrusion system.

Referring to Figure 1, the extruder generally designated 10 comprises a barrel 11 provided with a cooling jacket 12 having an inlet for cooling fluid 13 and an outlet for cooling fluid 14, an inlet for the feed material to be extruded 15, a die 16 having a circular cross-section and a diameter of 6.5mm, and a screw 17 whose root diameter increases from the upstream end to the downstream end and provided with threads 18 whose pitch is constant from the upstream end to the downstream end. The screw 17 is provided with a channel 19 for heating fluid extending from the upstream end to the downstream end having an inlet 20 connected with a concentric channel 21 leading to an outlet for the heating fluid 22.

The operation of the above described single screw extruder will now be described in the following Examples.

Example 1

Milk chocolate buttons having a temperature of 22°C are fed into the barrel 11 of the extruder 10 through the feed inlet 15. The screw 17 has a diameter of 32mm, a length to diameter ratio of 24:1, a 2:1 compression ratio and a screw speed of 65rpm. A 50:50 mixture of water and glycol at -5°C flows through the cooling jacket 12 of the barrel and water at 20°C flows through the channels 19 and 21 of the screw. As the screw rotates, the solid chocolate flows through at a rate of 15kg/hr and is extruded through the die 16 with a configuration conforming to that of the die and has a temporary flexibility which lasts for about 1 hour.

Example 2

Milk chocolate buttons having a temperature of 22°C are fed into the barrel 11 of the extruder 10 through the feed inlet 15. The screw 17 has a diameter of 50mm, a length to diameter ratio of 20:1, a 2:1 compression ratio and a screw speed of 70rpm. A 50:50 mixture of water and glycol at -10°C flows through the cooling jacket 12 of the barrel and water at 25°C flows through the channels 19 and 21 of the screw. As the screw rotates, the solid chocolate flows through at a rate of 50kg/hr and is extruded at 21°C through the die 16 with a configuration conforming to that of the die and has a temporary flexibility which lasts for about 1 hour.

Example 3

Milk chocolate buttons having a temperature of 22°C are fed into the barrel 11 of the extruder 10 through the feed inlet 15. The scr w 17 has a diameter of 90mm, a length to diameter ratio of 15:1, a 2:1 compression ratio and a screw speed of 35rpm. Water at 5°C flows through the cooling

jacket 12 of the barrel and water at 20°C flows through the channels 19 and 21 of the screw. As the screw rotates, the solid chocolate flows through at a rate of 280kg/hr and is extruded through the die 16 with a configuration conforming to that of the die and has a temporary flexibility which lasts for about 1 hour.

CLAIMS

1. A process for the continuous extrusion of chocolate or a fat-containing confectionery material using a screw extruder which comprises feeding the chocolate or fat-containing confectionery material into the screw extruder and generating a pressure to force the chocolate or fat-containing confectionery material in a substantially solid or semi-solid nonpourable form upstream of a flow constriction whereby the temperature of the screw, the temperature of the barrel wall, the screw speed, pressure, contraction ratio and extrusion rate are such that the chocolate or fat-containing confectionery material is extruded in a substantially solid or semi-solid nonpourable form to produce an axially homogeneous extruded product having a cross section that is of substantially the same profile as the die exit of the extruder, which is capable of retaining its shape and which has a temporary flexibility or plasticity enabling it to be physically manipulated or plastically deformed before losing its flexibility or plasticity.

2. A process according to claim 1 wherein the temperature of the screw is controlled by a fluid at the appropriate temperature flowing through the interior of the screw.

3. A process according to claim 2 wherein the fluid enters at the upstream end and flows to the downstream end through one or more longitudinal channels and returns through one or more longitudinal channels to the upstream end where it exits.

4. A process according to claim 1 wherein the temperature of the barrel wall is controlled by a fluid at the appropriate temperature flowing through a cooling jacket surrounding the wall of the barrel.

5. A process according to claim 1 wherein the temperature of the the screw is from 10° to 35°C.

6. A process according to claim 1 wherein the temperature of the barrel wall is from -50° to +20°C.

7. A process according to claim 1 wherein the temperature of the barrel wall is lower than the incoming chocolate or fat-containing confectionery material.

8. A process according to claim 1 wherein the temperature of the screw is greater than the temperature of the barrel by from 5° to 50°C.

9. A process according to claim 1 wherein the root diameter of the screw increases from the upstream to the downstream end while the pitch remains constant.

10. A process according to claim 1 wherein the pitch of the screw decreases from the upstream to the downstream end while the root diameter remains constant.

11. A process according to claim 1 wherein the pitch of the screw decreases from the upstream to the downstream end and the root diameter of the screw increases from the upstream to the downstream end.

12. A process according to claim 1 wherein the compression ratio of the screw is from 1:1 to 5:1.

13. A process according to claim 1 wherein the ratio of length to diameter of the screw is from 5:1 to 30:1.

14. A process according to claim 1 wherein the diameter of the screw is from 20 to 500mm.

15. A process according to claim 1 wherein the screw speed is from 1 to 500rpm.

16. A process according to claim 1 wherein the throughput of the chocolate or a fat-containing confectionery material is from 1 to 5000kg/hr.

17. A process according to claim 1 wherein the chocolate or fat-containing confectionery material may be co-extruded with another chocolate or fat-based confectionery material or another food material.

18. A process according to claim 18 wherein the other food material is ice cream, sorbet, yoghurt, mousse, fondant, praline, marshmallow, nougat, jelly or any other food material.

19. A process according to claim 1 wherein a twin screw extruder is used.

20. A process for the continuous extrusion of chocolate or a fat containing confectionary material using a screw extruder substantially as hereinbefore described with reference to the Examples.

The Patent Office

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Applicati n No: GB 9606285.6 **Examiner:** Monty Siddique
Claims searched: 1-20 **Date of search:** 23 May 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): A2B (BMC15, BMC19); B5A (AT17J, AT17M, AT17P, AT17X)

Int Cl (Ed.6): A23G 1/18 1/20 3/12

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB 2051656 A	(DORSEY...) controlling temperature in extruder to produce food product of desired shape	1 at least
Y	GB 0994554	(FLESSNER) see page 1 lines 48-70, controlling temperature in extruder to produce food product of desired shape	1 at least
X,Y	EP 0603467 A2	(NESTLE) entire document and page 4 lines 12-13	1 at least
Y	EP 0122887 A2	(PIAZOLA) controlling temperature in extruder by heating of cylinder and cooling of barrel	1 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.